DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5830
Ser N01/1228
4 Oct 17

FINAL ENDORSEMENT on CAPT (b)(6) and (b)(7)(C) JSN, ltr of 9 Sep 16

From: Commander, U.S. Pacific Fleet
To: File

Subj: COMMAND INVESTIGATION INTO THE MAIN PROPULSION DIESEL ENGINE (MPDE) CASUALTY ONBOARD USS FREEDOM (LCS 1) THAT OCCURRED ON OR ABOUT 11 JULY 2016

Ref: (j) CNRMCINST 4700.3C

Encl: (79) COMNAVSURFPAC e-mail ltr 4793/N00J of 31 Mar 17
(80) COMNAVSAFECEN 281844ZJUN17
(81) CNSP e-mail ltr 4793/N43P of 28 Jun 17
(82) PEO LCS WASHINGTON DC 031400ZAPR17

1. I reviewed the subject investigation and its substantive endorsement by Commander, Naval Surface Forces Pacific (COMNAVSURFPAC). Except as further modified below, I approve the findings of fact, opinions, and recommendations as endorsed by COMNAVSURFPAC.

2. With most mishaps, a series of factors often contribute to failure. This mishap is no different. I concur with the investigating officer's identification of the three main causes, and note that the desire to support Rim of the Pacific (RIMPAC), coupled with inadequate leadership engagement, led to the failure to communicate the risk up the chain of command.

3. The Senior enlisted personnel assigned to USS FREEDOM (LCS 1) were aware of the consequences of getting underway and delaying maintenance on the engine, and they communicated that risk to the Chief Engineer. When it was determined that the salt water contamination in the lube oil system was pervasive, there was a short window of opportunity to take immediate action and to save the diesel engine. Failure to candidly communicate the true status of the engine up the chain of command took away this opportunity.

4. Additional Recommendations. By copy of this endorsement, I add the following recommendations:

Recommendation 22. I recommend SWRMC conduct an internal critique, per reference (j), and forward the resulting report to COMNAVSURFPAC and the COMPACFLT Fleet Maintenance Officer, N43, within thirty (30) days of this endorsement.

Subj: COMMAND INVESTIGATION INTO THE MAIN PROPULSION DIESEL ENGINE (MPDE) CASUALTY ONBOARD USS FREEDOM (LCS 1) THAT OCCURRED ON OR ABOUT 11 JULY 2016

5. By copy of this endorsement, I direct COMNAVSURFPAC to aggressively address and track the issues identified in the subject investigation. Provide written updates to the COMPACFLT N43 point of contact, Mr. (b)(6) and (b)(7)(C) every thirty (30) days from the date of this final endorsement until otherwise directed. (b)(6) and (b)(7)(C) can be reached at (808) 474-6366 or via email at (b)(6) and (b)(7)(C)@navy.mil.

6. COMNAVSURPAC addressed the leadership deficiencies of DESRON SEVEN and LCSRON ONE through administrative actions.

7. My point of contact is Captain (b)(6) and (b)(7)(C) JAGC, USN, who can be reached at (808) 474-7880 or via email at (b)(6) and (b)(7)(C)@navy.mil.

(b)(6) and (b)(7)(C)

M. J. CARTER

Copy to:
COMNAVSURFPAC
COMNAVSEASYSCOM
PEO-LCS
COMLCSRON ONE
SWRMC
NSWC PHILADELPHIA
LCS 1 CREW 106
(b)(6) and (b)(7)(C)

DEPARTMENT OF THE NAVY
COMMANDER
NAVAL SURFACE FORCE
UNITED STATES PACIFIC FLEET
2841 RENDOVA ROAD
SAN DIEGO, CALIFORNIA 92155-5490

IN REPLY REFER TO
5830
Ser N00 / 913
8 Nov 16

From: Commander, Naval Surface Force, U.S. Pacific Fleet
To: Commander, U.S. Pacific Fleet

Subj: COMMAND INVESTIGATION INTO THE MAIN PROPULSION DIESEL ENGINE (MPDE) CASUALTY ONBOARD USS FREEDOM (LCS 1) THAT OCCURRED ON OR ABOUT 11 JULY 2016

1. I have reviewed the Investigating Officer's (IO) command investigation (CI) of 9 September 2016 and approve the findings of fact, opinions, and recommendations of the IO except as modified below.

2. Executive Summary. I concur with the IO's opinions regarding the three major errors that contributed to the catastrophic damage to USS Freedom's NR 2 MPDE. First, the crew wrongly decided to insert a DC plug into the engine's attached seawater pump telltale drain and failed to fully question the cause of the pump's failure or the ancillary ramifications of such failure. This deficiency can be partially attributed to the engineering department's lack of familiarity with the engineering plant, but also speaks to a lack of a questioning attitude or issue ownership. Second, all parties involved – to include the crew, the Regional Maintenance Center (RMC), and the Naval Surface Warfare Center Philadelphia Division In Service Engineering Agent (ISEA) – failed to adhere to the recommended procedure for saltwater contaminated engines in the appropriate technical manual. Rather, the ship followed guidance from the SWRMC Diesel Engine Inspector (DEI) and the ISEA to follow an incorrect procedure to clear the engine contamination. This error compounded the underlying casualty by providing false hope that the engine would be properly laid up free of contamination. Third, the Chief Engineer and the Commanding Officer ignored critical information regarding the unsatisfactory condition of the engine prior to the ship getting underway, withholding the same information from operational and administrative ISICs. In addition, I also believe that the technical community failed to support the crew in this casualty by recommending a less stringent saltwater contamination flushing procedure, and in doing so may have provided a false sense of procedural compliance to the crew. Technical representatives were not present for the flushing checkpoints and thus were unable to provide the necessary technical support for this casualty and operational impacts.

3. I can appreciate the burden borne by Crew 106, with an engineering department of only thirteen Sailors, in confronting multiple engineering casualties prior to and during RIMPAC. Nonetheless, I find that the pervasive corrosion found in USS Freedom's NR 2 MPDE was completely preventable if the right procedures had been followed and the CO had been forthcoming regarding the material condition of the ship's engine.

4. Recommendations.

a. Modifications: By copy of this endorsement, I modify IO's Recommendation 16 to read:

Recommended disciplinary action: COMNAVSURFPAC take appropriate administrative action concerning the Commanding Officer, Chief Engineer, Main Propulsion Assistant and Port Engineer. NAVSEA and SWRMC consider appropriate administrative action concerning the ISEA and the DEI.

b. Additional Recommendations: By copy of this endorsement, I add the following recommendations:

(1) Recommendation 17: SWRMC review internal procedures and Technical Authority application and clarity with respect to advising ships in accordance with the correct technical manual troubleshooting procedures and policies for approval of Departures From Specification when implementing unique maintenance and repair procedures.

(2) Recommendation 18: NSWC Philadelphia review internal procedures and Technical Authority application and clarity with respect to advising ships in accordance with the correct technical manual troubleshooting procedures and requirements for Departures From Specification when implementing unique maintenance and repair procedures.

(3) Recommendation 19: SWOS conduct an end-to-end review of available training for LCS engineering personnel.

(4) Recommendation 20: SWOS take overall lead for training delivery for LCS engineering training.

(5) Recommendation 21: SWOS conduct zero based review of LCS engineering manning and validate required LCS engineering billets.

c. By copy of this endorsement, LCSRON ONE is directed to act on IO's Recommendations 1, 2, and 10.

d. By copy of this endorsement, COMNAVSURFPAC N48 is directed to coordinate with PEO LCS on IO's Recommendation 12.

e. By copy of this endorsement, I request that NAVSEA consider action regarding IO's Recommendations 3-7, 13-15 and 16, as modified.

f. By copy of this endorsement, I request that PEO LCS consider action regarding IO's Recommendations 8-9 and 12.

g. By copy of this endorsement, I request that SWOS consider action regarding IO's Recommendation 11 and Additional Recommendations 19-21.

h. By copy of this endorsement, I request that SWRMC consider action regarding IO's Recommendation 16 as modified and Additional Recommendation 17.

Subj: COMMAND INVESTIGATION INTO THE MAIN PROPULSION DIESEL ENGINE (MPDE) CASUALTY ONBOARD USS FREEDOM (LCS 1) THAT OCCURRED ON OR ABOUT 11 JULY 2016

i. By copy of this endorsement, I request that NSWC Philadelphia consider action regarding Additional Recommendation 18.

5. Action:

a. COMNAVSURFPAC N04 execute LCS Design Summit to address design issues identified via this and other investigations concerning both LCS variants. This summit will include stakeholders from NAVSEA, PEO LCS, PMS 501, and PMS 505, with the goal of developing a consolidated and coordinated way ahead on LCS design challenges and processes to ensure learning across each variant. Prepare proposed recommendations by the end of calendar year 2016.

b. By copy of this endorsement, I direct the commands under the administrative chain of command of COMNAVSURFPAC to aggressively address and track the actions items listed in paragraph 4 of this endorsement. Report completion to COMNAVSURFPAC N00J.

c. Matters involving requirements for commands outside the administrative chain of command of COMNAVSURFPAC will be forwarded under separate correspondence, recommending ISIC approval and coordination consistent with command and control authorities and procedures.

6. My point of contact for this investigation is [redacted], JAGC, USN, at [redacted]

[redacted]

T. S. ROWDEN

Copy to:
COMPACFLT
COMNAVSEASYSCOM
PEO-LCS
COMLCSRON ONE
SWRMC
NSWC PHILADELPHIA
LCS 1 CREW 106
[redacted]

9 Sep 2016

From: [redacted]
To: Commander, Naval Surface Force, U.S. Pacific Fleet

Subj: COMMAND INVESTIGATION INTO THE MAIN PROPULSION DIESEL ENGINE (MPDE) CASUALTY ONBOARD USS FREEDOM (LCS 1) THAT OCCURRED ON OR ABOUT 11 JULY 2016

Ref: (a) JAG Manual 5800.7F
(b) S9233-DT-MMC-010, Fairbanks Morse, Main Propulsion Diesel Engine; Operation and Maintenance With Parts List for Littoral Combat Ships
(c) NAVSEA Document MSF/0001/033116, USS Freedom (LCS 1) Main Space Flooding EOCC
(d) S9086-HB-STM-010, Naval Ships' Technical Manual, Chapter 233 – Diesel Engines
(e) NAVSEA Document DFM/0887/060415, USS Freedom (LCS 1) Firemain System Diagram
(f) NAVSEA Document DMDP/0863/090415, USS Freedom (LCS 1) Main Diesel Piping Diagram
(g) S9086-H7-STM-010, Naval Ships' Technical Manual, Chapter 262 – Lubricating Oils, Greases, Specialty Lubricants, and Lubrication Systems
(h) NAVSEA Document MRC 2331/025 R-43W (H8MQ), Perform Analysis for Water in Oil Obtained from MPDE Sump Using Kittewake Oil Center (OTC)
(i) S0400-AD-URM-010, NAVSEA Technical Publication Tag-Out Users Manual

Encl: (1) Commander, Naval Surface Force, U. S. Pacific Fleet, Appointment Order to [redacted], USN, as Investigating Officer, 25 Aug 16
(2) Preliminary Inquiry Report Into the Facts and Circumstances Surrounding Damage To NR2 Main Propulsion Diesel Engine In USS Freedom (LCS 1) on or about 11 July 2016, [redacted], USN, Preliminary Inquiry Officer, 26 Aug 16
(3) Field Service Report, USS Freedom (LCS 1) NR1 Main Propulsion Diesel Attached Seawater Pump, Fairbanks Morse Engine San Diego Service Center, SWRMC Code 264, 03 August 2016
(4) Condition Found Report, USS Freedom (LCS 1) NR1 Main Propulsion Diesel Attached Seawater Pump, Fairbanks Morse Engine San Diego Service Center, SWRMC Code 264, 03 August 2016
(5) Email Between [redacted], Program Manager, Fairbanks-Morse Engine San Diego Service Center , and [redacted], 12 February 2014, 0851
(6) NOAP Laboratory Sample Results, USS Freedom (LCS 1) NR1 Main Propulsion Diesel Engine, 21 February 2014
(7) Copy of USS Freedom (LCS 1) Engineering Log 11 Jul-10 Aug 2016
(8) Statement, [redacted], to [redacted], USN, Investigating Officer, 29 Aug 16
(9) Statement, [redacted], to [redacted], USN, Investigating Officer, 29 Aug 16

(10) Statement, [redacted], to [redacted], USN, Investigating Officer, 29 Aug 16
(11) Email Between [redacted], USS Freedom Engineer Officer, and [redacted], Investigating Officer, 6 September 2016, 1047, 1556
(12) EOSS Diagram DMDP/0863/090415, Ref (f), Page 1
(13) Statement, [redacted], USS Freedom (LCS 1) Senior Enlisted Engineer, to [redacted], USN, Investigating Officer, 30 Aug 16
(14) EOSS Diagram DFM/0887/060415, Ref (e), Page 4
(15) Statement, [redacted], to [redacted], USN, Investigating Officer, 29 Aug 16
(16) Prelube Pump Operation Description, Ref (b), Para. 3-20.3.
(17) Statement, [redacted], USS Freedom Engineer Officer, to [redacted], USN, Investigating Officer, 29 Aug 16
(18) Statement, [redacted], USS Freedom (LCS 1) Port Engineer, to [redacted], USN, Investigating Officer, 31 Aug 16
(19) Attached Seawater Pump Cross-Section Schematic, Ref (b). Page 6-363
(20) Attached Seawater Pump Cross-Section Schematic, Enhanced View of Pump Mechanical Seal, Ref (b), Page 6-299
(21) Email Between [redacted], USS Freedom Engineer Officer, [redacted], N4, COMLCSRON ONE, [redacted] NSWC-PH, and [redacted], CNSP N43, 12 July 2016, 0803
(22) Photo of Attached Seawater Pump
(23) SKED View Depicting NR2 MPDE Completion of MRC 4M-7 (F4AW), Inspect Seawater Pump Mechanical Seal for Excessive Leakage, on 27 April 2016
(24) Description of Attached Seawater Pump, Ref (b), Para. 6-8.2.2
(25) Fairbanks Morse, Colt-Pielstick 16PA6B-STC Engine Characteristics, Operational Conditions, and Data, Ref (d), Pages 1-15, 16, 19, and 20
(26) Crankcase Exhauster System, Ref (d), Page 1-13
(27) Crankcase Exhauster System, Ref (d), Page 3-72
(28) Email Between [redacted], USS Freedom Engineer Officer, [redacted], N4, COMLCSRON ONE, [redacted] NSWC-PH, and [redacted], CNSP N43, 12 July 2016, 1057
(29) Statement, [redacted], to [redacted], USN, Investigating Officer, 29 Aug 16
(30) Figure of Fairbanks Morse, Colt-Pielstick 16PA6B-STC Engine Showing Crankline Relative to Dipstick Tube
(31) Fairbanks Morse, Colt-Pielstick 16PA6B-STC Timing Gear Train, Ref (b), Page 3-75
(32) Attached Seawater Pump Cross-Section Schematic, Enhanced View of Crank Case Oil Lip Seal, Ref (b), Page 6-286
(33) Attached Seawater Pump Cross-Section Schematic, Alternate, Ref (b), Page 7-44
(34) Photo of Casualty Sample from NR2 MPDE Following Discovery of Seawater Contamination
(35) Post-Overhaul or Repair, Lube Oil System Intensive Cleaning, Applicable Sections,

Ref (d), Para. 233-8.21

(36) Table Showing Ship Classes and Associated Commercial Oils Used, Ref (g), Table 262-8-1

(37) Email Between [redacted], USS Freedom Engineer Officer, and [redacted] N4, COMLCSRON ONE, 13 July 2016, 0711

(38) Email Between [redacted], USS Freedom Senior Enlisted Engineer and [redacted], SWRMC DEI, 13 July 2016, 0243-0859

(39) Screen Shots of Shift Operations Management System Tag Out Showing Isolations Incident to NR2 MPDE Attached Seawater Cooling Pump and Follow-On Casualty

(40) Procedures for Treatment After Immersion in Seawater, and Immediate Reuse Following Immersion, Ref (d), Para. 233-6.17, 18, 19

(41) Caution Stating Low Flash Point of MIL-L-16173, Ref (d), Para 233-6.11.1

(42) Procedures for Laying Up Diesel Engines When Motoring is Not Possible, and Starting Diesel Engines After Preservation With Compounds, Ref (d), Para. 233-6.15, 6.16

(43) Statement, [redacted], USS Freedom Executive Officer, to [redacted], USN, Investigating Officer, 31 Aug 16

(44) Email Between [redacted], USS Freedom Engineer Officer, and [redacted], Investigating Officer, 1 September 2016, 1725

(45) Copy of USS Freedom (LCS 1) Deck Log for 11-13 Jul 2016

(46) Email Between CAPT Jeffrey Cronin, CTG 177.2, and CAPT Keith Knutsen, Commander CTF-52, 14 July 2016, 0310

(47) Email Between CAPT Jeffrey Cronin, CTG 177.2, and RDML James Kilby, Commander, Surface and Mine Warfighting Development Center, 14 July 2016, 1803

(48) Email Between [redacted], NSWC Philadelphia, Code 421/2 ISEA, and [redacted], Investigating Officer, 6 September 2016, 1125

(49) LHD 8 Flush Procedure for Lube Oil Circulation Before Engine Startup, "Makin Island Circulation Procedure"

(50) Email Between [redacted], SWRMC DEI, [redacted], USS Freedom (LCS 1) Port Engineer, and [redacted], NSWC Philadelphia, Code 421 ISEA, 14 July 2016, 1240 -15 July 2016, 1217

(51) Statement, CDR Michael Wohnhaas, USS Freedom Commanding Officer, to [redacted], USN, Investigating Officer, 31 Aug 16

(52) Guidance and Policy for Surface Ship Critical Systems and Other Work Requiring Process Control Procedures (PCP), Commander, Navy Regional Maintenance Center, 20 November 2015

(53) Photos of NR2 MPDE Pre-Flush, 16 July 2016

(54) Email Between [redacted], USS Freedom (LCS 1) Port Engineer, and [redacted] SWRMC DEI, 14 July 2016, 1235

(55) Photos of NR2 MPDE Lube Oil Flushing Samples, 16-17 July 2016

(56) Statement, [redacted], USS Freedom Main Propulsion Assistant, to [redacted], USN, Investigating Officer, 30 August 16

(57) Email Between [redacted], USS Freedom Engineer Officer, and [redacted]

Subj: COMMAND INVESTIGATION INTO THE MAIN PROPULSION DIESEL ENGINE (MPDE) CASUALTY ONBOARD USS FREEDOM (LCS 1) THAT OCCURRED ON OR ABOUT 11 JULY 2016

[redacted], Investigating Officer, 5 September 2016, 1119
(58) Statement, [redacted], USS Freedom Combat Systems Officer, to [redacted], USN, Investigating Officer, 6 September 16
(59) Email Between CDR Michael Wohnhaas, Commanding Officer, USS Freedom (LCS 1), and [redacted], Investigating Officer, 31 August 2016, 1506
(60) Email Between CDR Michael Wohnhaas, Commanding Officer, USS Freedom (LCS 1), and CAPT Jeffrey Cronin, CTG 177.2, 17 July 2016, 1131
(61) Email Between CDR Michael Wohnhaas, Commanding Officer, USS Freedom (LCS 1), and CAPT Warren Buller, Commander, Littoral Combat Ships Squadron ONE, 17 July 2016, 1136
(62) Email Between CDR Michael Wohnhaas, Commanding Officer, USS Freedom (LCS 1), and CAPT Warren Buller, Commander, Littoral Combat Ships Squadron ONE, 18 July 2016, 0906
(63) Photo of NR2 MPDE Lube Oil Samples, 24 July 2016
(64) Email Between [redacted], USS Freedom Engineer Officer, and [redacted], Investigating Officer, 6 September 2016, 1620
(65) Email Between CDR Michael Wohnhaas, Commanding Officer, USS Freedom (LCS 1), and [redacted], Investigating Officer, 6 September 2016, 1556
(66) Photos of NR2 MPDE 17 Days After Sump Flush, 3 August July 2016
(67) Technical Assist Visit Report, USS Freedom (LCS 1) NR2 Main Propulsion Diesel Engine Seawater Contamination, SWRMC Code 264, 03 August 2016
(68) Shipboard Diesel Engine Oil Sampling Frequency for Ships Not Under Diesel Readiness System (DRS) Program, Ref (g), Para 262-6.5.1
(69) SAE 40 as an Acceptable Substitute to MIL-PRF-9000, Ref (g), Table 262-2-1, Para 262-2.2.1.2.1
(70) Statement, CAPT Warren Buller, Commander, Littoral Combat Ships Squadron ONE, to [redacted], USN, Investigating Officer, 29 Aug 16
(71) Statement, CAPT Jeffrey Cronin, CTG 177.2, to [redacted], USN, Investigating Officer, 29 Aug 16
(72) Statement, [redacted], USS Freedom Auxiliaries Officer, to [redacted], USN, Investigating Officer, 29 Aug 16
(73) Statement, [redacted], USS Freedom, to [redacted], USN, Investigating Officer, 29 Aug 16
(74) Statement, [redacted], USS Freedom, to [redacted], USN, Investigating Officer, 29 Aug 16(75) Statement, [redacted], to [redacted], USN, Investigating Officer, 29 Aug 16
(76) Statement, [redacted] and [redacted], SWRMC, to [redacted], USN, Investigating Officer, 30 Aug 16
(77) Statement, [redacted], LCSRON ONE, to [redacted], USN, Investigating Officer, 29 Aug 16
(78) SWRMC Timeline of Events

Subj: COMMAND INVESTIGATION INTO THE MAIN PROPULSION DIESEL ENGINE (MPDE) CASUALTY ONBOARD USS FREEDOM (LCS 1) THAT OCCURRED ON OR ABOUT 11 JULY 2016

Preliminary Statement

1. Purpose and Scope. In accordance with reference (a), and pursuant to enclosure (1), this Command Investigation (CI) inquires into the facts and circumstances involving the ruination of NR 2 Main Propulsion Diesel Engine (MPDE) on USS FREEDOM (LCS 1), which occurred during the period of 11-29 July 2016. It addresses the casualty's potential sources or causes, the engineering plant's material condition, casualty control and maintenance actions taken, watchstander level of knowledge and procedural compliance, and the adequacy of prescribed technical procedures. In addition, it touches on whether or not issues beyond the ship's lifelines, to include the broader LCS class maintenance concept, contributed to the casualty.

2. Method and Approach. I was assisted in this investigation by (b) (6), (b) (7)(C) of Littoral Combat Ship Squadron ONE (LCSRON ONE), who conducted a Preliminary Inquiry (enclosure (2)) into this incident prior to the Command Investigation. The PI was conducted during the period of 26 August-9 September 2016, during which time the investigators worked from the LCSRON ONE spaces. The Investigating Officer visited the ship to see firsthand, in-situ, the affected engine. The Naval Sea Systems Command (NAVSEA) Diesel Engine Technical Warrant Holder, Mr. (b) (6), (b) (7)(C), and (b) (6), (b) (7)(C) (LCSRON ONE) provided technical expertise.

In our efforts to understand the casualty's cause and the watchstander and repair actions taken in its aftermath, we reviewed Technical Assist Visit Reports (TAVRs), ship's logs, Preventive Maintenance System (PMS) records, Original Equipment Manufacturer technical manuals, and Naval Ships Technical Manuals. In addition, we interviewed the principal watchstanders who were on watch during the casualty, as well as key personnel involved in troubleshooting and repairing the engine. Shore-based technical support personnel, the ship's maintenance team, the commanding officer and executive officer, and the operational and administrative ISICs were also interviewed. In total, 21 personnel who were either directly or tangentially involved with the casualty provided statements.

3. Background. The ship's commanding officer, CDR Michael Wohnhaas, assumed command of LCS Crew 106 on 1 July 2015 and assumed command of USS Freedom on 9 May 2016. The ship's executive officer, (b) (6), (b) (7)(C), reported aboard on 14 February 2014. The ship's engineer officer, (b) (6), (b) (7)(C), reported to Crew 106 on 4 December 2014. Crew 106 engineers had very little on-hull experience prior to reporting to the ship.

At the time of the casualty, USS FREEDOM was underway supporting Rim of the Pacific (RIMPAC) 2016 Exercise in the Southern California (SOCAL) Operations Area (OPAREA). Two RIMPAC phases were held in the SOCAL OPAREA. The first phase, Force Integration, was from 5-15 July; the second phase, Freeplay, was from 18-29 July. USS FREEDOM originally was scheduled to get underway in support of RIMPAC on 8 July, but was delayed due to problems with MPCMS. USS FREEDOM got underway on 9 July with 39—mostly Explosive Ordnance Disposal (EOD)—personnel onboard to support the Expeditionary

Mine Countermeasure (Ex-MCM) concept, which was to be demonstrated during the Freeplay Phase.

USS FREEDOM's support to RIMPAC came at a sensitive time for the LCS program, which had suffered a series of recent, high-visibility casualties, to include engineering casualties to USS Milwaukee (LCS 5), which broke down in December 2015 during its initial underway period; and USS Fort Worth (LCS 3), which in January 2016 sustained significant damage to its main reduction gear while operating forward. In addition to the NR 2 MPDE casualty addressed here, USS FREEDOM experienced numerous other engineering casualties throughout the RIMPAC period. The ship's engineering department is comprised of 15 personnel, to include all officers, non-commissioned officers, and junior enlisted personnel.

Note. All listed times are local shipboard times (L).

Note. Per NSTM 233, Diesel Engines, Para 233-8.20: "The clear and bright test is ineffective for diesel engine lubricating oils." Precisely determining the seawater content of a diesel engine lubricating oil sample requires laboratory testing.

Note. The flush procedure that was used in attempt to clean the NR 2 MPDE sump upon the ship's return to port following the casualty (16-17 July) was adopted from a procedure performed previously onboard USS Makin Island (LHD 8). It is referred to throughout this report as the "Makin Island Circulation Procedure."

Note. In November, 2013 USS FREEDOM sustained a seawater contamination casualty on NR1 MPDE due to a leaking or failed attached seawater pump mechanical seal. As in this instance, ship's force plugged the pump telltale. *This is therefore the second known MPDE seawater contamination casualty stemming from a plugged telltale on this ship*. [Enclosure (3), (4), (5), (6)]

Findings of Fact

1. USS FREEDOM got underway for RIMPAC on 9 July 16, a delay of one day, which was caused by MPCMS software issues. The ship submitted a "Fail to Sail" message alerting the operational commander, CAPT Jeffrey Cronin, that they could not get underway on time. [Enclosure (71)]

2. On 11 July, on or about 1745, the ship experienced a loss of firemain pressure. In response, the Readiness Control Officer (RCO), (b) (6), (b) (7) (C), ordered the Maintainer, (b) (6), (b) (7) (C), to visually inspect and vent NR 1 fire pump, and ordered NR 3 fire pump to be started (note: the RCO normally has the capability to remotely start a fire pump from the RCO Console (RCOC), but in this instance had to start it locally due to ongoing issues with the Machinery Plant Control and Monitoring System (MPCMS). [Enclosure (13)]

3. Starting NR 3 fire pump restored system pressure to normal, but when the pump was subsequently stopped (1746L), the pressure again registered low. In response, the RCO ordered all available engineering personnel to check for firemain system leaks. [Enclosure (7), (8)]

4. In the process of checking for firemain system leaks, (b) (6), (b) (7)(C) discovered water (1"-2") on deck in the Main Machinery Room lower level. (b) (6), (b) (7)(C) reported major flooding to the RCO, and it was announced over the ship's 1MC. [Enclosure (9)]

5. Closer examination of MMR lower level revealed water emanating from the free end of NR 2 MPDE at a rate of approximately 20-30 gal/minute. [Enclosure (10)]

6. In response to the leak from NR 2 MPDE, the engine was stopped and efforts were undertaken to isolate the leak by securing seawater supply to the engine. [Enclosure (7), (9), (11), (12), (13)]

7. (b) (6), (b) (7)(C), the ship's Senior Enlisted Engineer, and (b) (6), (b) (7)(C) secured seawater isolation valves MSW-V-164B and MSW-V-49B, respectively. Later, ship's force secured valves MSW-V-165B and MSW-V-161B. [Enclosure (7), (9), (11), (12), (13)]

8. Efforts to isolate engine seawater supply were only partially successful. Securing the isolation valves reduced but did not stop the leak. There is no record that FM-V-117, which would have secured the back-up firemain cooling branch off of the main firemain header, was isolated. When this valve was secured by contractors on 15 July in preparation for installing blank flanges, the leak-by rate slowed considerably. [Enclosure (11), (12), (14)]

9. (b) (6), (b) (7)(C) crawled beneath NR 2 MPDE to determine where the leak was coming from. He observed water emanating from a small (1/2") hole in the spacer between the attached seawater pump and the engine crankcase. He used his finger to probe the hole and observed that it was threaded. He reported this fact to (b) (6), (b) (7)(C), who surmised that the source of the leak must be a pump casing drain whose plug (i.e., cap) had gotten detached or gone missing. [Enclosure (10), (15)]

10. In an effort to stem the leak, (b) (6), (b) (7)(C) directed (b) (6), (b) (7)(C) to insert a DC plug into the hole. (b) (6), (b) (7)(C) initial attempt to plug the hole was unsuccessful. His second attempt using a smaller plug succeeded, though he received second degree burns in the process when his arm brushed up against a hot pipe. The plug was secured in place with a hose clamp. [Enclosure (10), (15)]

11. The MMR was dewatered using a NR 2 eductor. [Enclosure (7)]

12. When NR 2 MPDE was shut down, its prelube pump remained running for 5 minutes. [Enclosure (16)]

13. NR 2 MPDE's keep-warm system remained on following engine shutdown. When the keep-warm system is on the prelube pump runs continuously, circulating lube oil throughout the engine. The prelube pump takes suction off the bottom of the sump. [Enclosure (16)]

14. Upon completion of his TAO watch, at approximately 2300L, the engineer officer reviewed the MDPE attached seawater pump technical drawings [Enclosure (5)] with the Port Engineer, (b) (6), (b) (7)(C), and (b) (6), (b) (7)(C). The review of the schematic led the group to believe the source of the leak might be a telltale rather than a casing drain. [Enclosure (13), (17), (18), (19), (20)]

15. Following his review of the schematic, the engineer officer investigated the leak source and confirmed the DC plug was inserted into a telltale, not a casing drain as originally believed. [Enclosure (17), (21), (22)]

16. The casing drain is located on the attached seawater pump casing, but very near (~12 cm) the spacer telltale. Both are located at the 6 o'clock position. [Enclosure (22)]

17. The attached seawater pump spacer telltale is not easily observable and is difficult to access. [Enclosure (22)]

18. The attached seawater pump telltale is designed to alert operators that there is a leaking or failed attached seawater pump mechanical seal. [Enclosure (24)]

19. Periodic (every 4 months) PMS on the NR 2 MPDE attached seawater pump mechanical seal was current, and was registered as having been performed in SKED on 27 April, 2016. (4M-7 F4AW Inspect Seawater Pump Mechanical Seal for Excessive Leakage). [Enclosure (23)]

20. The Original Equipment Manufacturer (OEM), Fairbanks Morse, technical manual for the Colt-Pielstick 16PA6B STC diesel engine (S9233-DT-MMC-010/LCS) states that the telltale should have a "fitted pipe" in the pump casing. [Enclosure (24)]

21. The NR 2 MPDE attached seawater pump is a non-positive displacement, centrifugal pump rated at 1540 GPM/42 psi. [Enclosure (25)]

22. NR 2 MPDE has a maximum RPM of 1050. [Enclosure (25)]

23. Emergency back-up seawater cooling is provided by firemain reduced from 150 psi to 45 psi. Back-up seawater cooling is provided only in the event of a loss of attached seawater pump pressure. [Enclosure (14)]

24. The MPDE crankcase is under constant vacuum (0.79-1" of water (0.04 psi of vacuum)) when the engine is running to maintain a slight negative pressure. [Enclosures (26), (27)]

25. On the morning of 12 July, the ship's engineering department was focused on repairing NR 1 MPDE. No action was taken regarding NR 2 MPDE. The DC plug remained inserted in the NR 2 MPDE attached seawater pump telltale. [Enclosures (28)]

26. On 12 July, at 2320L, the ship's Maintainer, (b) (6), (b) (7) (C), reported oil on the deck (approximately 5-15 gal) in the vicinity of NR 2 MPDE. DC3 (b) (6), (b) (7) notified the RCO, who notified the engineer officer, who was on watch as TAO. [Enclosure (8), (17), (29),]

27. The engineer officer proceeded to the MMR to assess the situation himself. Upon arrival, (b) (6), (b) (7) (C) informed the engineer officer that emulsified oil was leaking from the NR 2 MPDE sump dipstick tube. [Enclosure (8), (17), (29)]

28. The NR 2 MPDE dipstick tube is located just below the engine crank line. [Enclosure (30)]

29. The NR 2 MPDE attached seawater pump is driven via the MPDE main drive gear, which meshes with an idler pinion that drives the seawater pump pinion. This shaft exits the crankcase via a lip seal located just below the crank line. [Enclosures (30), (31), (32), (33)]

30. The casualty lube oil sample taken from the NR 2 MPDE sump following the discovery of emulsified oil on the MMR deck revealed significant seawater contamination. [Enclosure (34)]

31. Per NSTM 233, Diesel Engines, Para 233-8.21.17 (pp 233-8-22): "Diesel engine lubricating oil has an affinity for water. Oil will turn to a coffee cream or khaki color if oil is heavily contaminated with water." [Enclosure (35)]

32. Per NSTM 262 - LUBRICATING OILS, GREASES, SPECIALTY LUBRICANTS, AND LUBRICATION SYSTEMS, Para 262-6.5.1 (SHIPS NOT UNDER DIESEL READINESS SYSTEM (DRS) PROGRAM), Para 262-6.5.1.4.a, after an equipment casualty, casualty samples shall also be sent for off-ship analysis as per engineering casualty control (EOCC) to test for viscosity or fuel dilution/thickening. [Enclosure (69)]

33. There was no evidence to suggest that ship's force sent casualty lube oil samples for off-ship analysis at any time during the period 11-29 July 16; nor was there evidence that they sent any of the beginning, midpoint, and endpoint samples taken during the application of the Makin Island Circulation Procedure (16-17 July) for off-ship analysis.

34. Planned Maintenance System (PMS) Maintenance Index Page (MIP) 2331/025 Maintenance Requirement Card (MRC) R-43W (H8MQ)—Perform Analysis for Water in Oil Obtained from MPDE Sump Using Kittiwake Oil Test Center (OTC) (Ref h) does not stipulate that a water content test must be performed following a water/seawater intrusion casualty to an engine. [Reference (8)]

35. There was no evidence to suggest that ship's force performed the MRC R-43W (H8MQ) water content test on any casualty sample taken during the period 11-29 July 16; nor was there

evidence that they tested any of the beginning, midpoint, and endpoint samples taken during the application of the Makin Island Circulation Procedure (16-17 July 16) for water content.

36. Freedom is not covered under the Diesel Readiness System (DRS) program. [Enclosure (36)]

37. The engineer officer discussed the emulsified oil casualty with (b) (6), (b) (7)(C). They believed the most likely source of the seawater contamination was the combination cooler. [Enclosure (37)]

38. On 13 July 16, at 0140-0202L, the ship emptied NR 2 MPDE sump to the oily waste system. Approximately 990 gals of liquid were transferred (sump capacity is 550 gal). [Enclosure (7)]

39. On 13 July 16, at approximately 0200, the engineer officer showed the NR 2 MPDE casualty sample to the ship's Port Engineer, (b) (6), (b) (7)(C), who suggested the casualty was likely related to the earlier attached seawater pump casualty. [Enclosure (17), (18)]

40. On 13 July 16, at 0243L, (b) (6), (b) (7)(C) sent an email to the Southwest Regional Maintenance Center (SWRMC) DEI, (b) (6), (b) (7)(C), informing him of the seawater intrusion casualty to NR 2 MPDE. [Enclosure (38)]

41. On 13 July 16, from 0313-0318L, the ship again transferred liquid from the engine sump to the oily waste system. The amount transferred was not entered in the ship's Engineering Log. [Enclosure (7)]

42. Although NR 2 MPDE seawater cooling system isolation valves remained shut and the engine tagged out, seawater leaked continuously into the MPDE until the seawater cooling system piping was blanked off on 15 July 16. [Enclosures (7), (12), (14), (17), (39), Reference (f)]

43. On 13 July 16, at 0859L, (b) (6), (b) (7)(C) responded to (b) (6), (b) (7)(C) that the seawater intrusion into the MPDE was likely due to the attached seawater pump telltale having been plugged. [Enclosure (38)]

44. (b) (6), (b) (7)(C) email reply to (b) (6), (b) (7)(C) recommended the ship address the seawater intrusion casualty immediately by following the steps outlined in NSTM 233, Diesel Engines, Para 233-8.21.17 (Water Contamination Flush). [Enclosure (38)]

45. On 13 July 16, at 1005L, NR 2 MPDE was tagged out, to include the engine prelube pump. The prelube/keep-warm system activates when the engine is stopped (auto function). The prelube pump is rated at 44 GPM / 90 psi. [Enclosure (39), (49)]

46. On 13 July 16, at 1033L, NR2 MPDE prelube pump was tagged back in to empty NR2 MPDE sump. The prelube pump remained available for sump evacuation while the keep-warm system remained tagged out. [Enclosure (39)]

47. The ship performed portions of NSTM 233, Diesel Engines, Para 233-8.21.17 Step 3, which call for draining the sump, but did not perform any additional steps prior to returning to homeport. According to the engineer officer, ship's force did not mechanically clean NR 2 MPDE internals until 3 August 16. [Enclosure (35)]

48. NSTM 233, Diesel Engines, Para 233-8.21.17 Step 8 calls for starting the affected engine and running it at idle for 5 minutes. The ship could not have accomplished this step prior to pulling into port due to the casualty to the attached seawater pump. [Enclosure (35), (39)]

49. NSTM 233, Diesel Engines, Para 233-8.21.17 NOTE g states that if an engine or engine space has been flooded the operator is to refer to NSTM 233, Diesel Engines, Section 6. [Enclosure (35)]

50. NSTM 233, Diesel Engines, Section 6 Para 233-6.17 (TREATMENT AFTER IMMERSION IN SEAWATER) and 6.18 (IMMEDIATE REUSE FOLLOWING IMMERSION) highlight the importance of taking prompt action in the wake of seawater contamination, to wit [Enclosure (40)]:

- "Equipment which has become wet and is likely to become damaged due to corrosion can be saved if prompt corrective measures are taken." (6.17)
- "In order to minimize engine damage from water contamination, it is critical to remove water and operate engine as soon as possible after contamination occurs." (6.18)

51. NSTM 233, Diesel Engines, Section 6 Para 233-6.17.2 directs the use of MIL-C-16173 Grade 3 rust preventive compound, which "is intended for displacing water and to inhibit further corrosion of machinery which has been submerged. Full advantage should be taken of the capacity of this compound to remove water from the surface of any wetted metal subject to corrosion." The ship could not have accomplished this procedure because it does not possess the rust preventive compound. (Note. Ships are unlikely to store this compound onboard due to its low flashpoint (100 deg F.)). [Enclosures (40), (41)]

52. NSTM 233, Diesel Engines, Section 6 Para 233-6.18 states, "If it is suspected that water contamination occurred more than 24 hours prior to discovery, then a visual inspection of internal engine parts shall be conducted by a certified diesel engine inspector, if available." [Enclosure (40)]

53. NSTM 233, Diesel Engines, Section 6 Para 233-6.18 requires the engine to be started once the rust inhibitor compound has been applied and allowed to drain. The ship could not have accomplished this step due to the casualty to the attached seawater pump. [Enclosures (39), (40)]

54. The ship could not fully execute the procedures called out in NSTM 233, Diesel Engines, Sections 6 Para 233-6.17/6.18, or Section 8 Para 233-8.21.17, because each of these procedures requires starting the affected engine. [Enclosures (35), (39)]

55. NSTM 233, Diesel Engines, Section 6 Para 233-6.19.1 (ENGINES AND PARTS FOR DELAYED REPAIR) states, "Wetted equipment which is being prepared for delayed repair should be treated in accordance with paragraph 233-6.15." [Enclosure (28)]

56. NSTM 233, Diesel Engines, Section 6 Para 233-6.15 (LAYING UP DIESEL ENGINES WHEN MOTORING IS NOT POSSIBLE) spells out the steps that must be followed to lay up a diesel engine that cannot be started. [Enclosure (40), (42)]

57. On the morning of 13 July 16, the engineer officer recommended to the commanding officer that the ship pull into homeport for repairs to both NR 1 GTM Fuel Service Pump and NR 2 MPDE. [Enclosure (17), (43)]

58. On 13 July 16, from 1259-1305L, the ship emptied NR 2 MPDE sump to the oily waste system. The amount transferred was not entered in the ship's Engineering Log. [Enclosure (7)]

59. The ship did not add new oil to NR2 MPDE sump after repeatedly emptying the sump on 13 July 16. [Enclosure (44)]

60. On 13 July 16, at 1804L, USS FREEDOM arrived at Naval Base San Diego to effect repairs. [Enclosure (45)]

61. The ship's Port Engineer estimated the time to fully repair NR 2 MPDE, to include its attached seawater pump, at 2 weeks. [Enclosure (18)]

62. The ship's operational (CTG 177.2) and administrative (COMLCSRON ONE) ISICs discussed the casualty to NR 2 MPDE and agreed that, given the estimated period of performance of two weeks to fully repair the engine, the engine would not be repaired prior to the ship's scheduled underway on 18 July 16. Instead, it was agreed that the engine would be stabilized and the ship would get underway on 18 July 16 with NR 2 MPDE unavailable, i.e., 3 of 4 main engines available. [Enclosure (46), (47)]

63. On 14 July 16, RDML Kilby, CTF 177 Commander, visited the ship and discussed the maintenance plan with the ship's commanding officer. [Enclosure (45)]

64. PA6B diesels utilize only one cooler, a combination cooler with a plate heat exchanger, to cool both lube oil and jacket water with seawater. Since the lube oil system is internal to the block, it is difficult to isolate the combination cooler. Flushing the PA6B diesel at high pressure may compromise the titanium plate gaskets. [Enclosure (48)]

65. On 14 July 16, the SWRMC DEI, (b) (6), (b) (7)(C), provided the ship's Port Engineer with a proposed "flush" procedure that had been used previously used aboard USS Makin Island. He made clear that the procedure would first have to be approved by NAVSEA. (Note. Makin

Island's SSDGs are the same make and model diesel engine—the Colt-Pielstick 16PA6B STC—as Freedom's MPDEs.). [Enclosures (49), (50)]

66. (b) (6), (b) (7)(C) recommended the Makin Island Circulation Procedure because he believed the NR 2 MPDE seawater contamination was limited to the engine sump. The SWRMC Code 264 Branch Head, ((b) (6), (b) (7)(C)) was made aware, via email, that the Makin Island Circulation Procedure was being proposed for USS FREEDOM. [Enclosures (49), (50)]

67. Neither (b) (6), (b) (7)(C) , nor any other qualified DEI, conducted a visual inspection of NR 2 MPDE during the period 13-18 July 16. [Enclosures (17)]

68. A Process Control Procedure (PCP) for flushing the PA6B diesel engine was not readily available. A Process Control Procedure (PCP) for the Makin Island Circulation Procedure was not generated. [Enclosure (17), (18), (51)]

69. CNRMCINST 4700.5B Para 4.e states, "in emergent situations where work on a Critical System is required, and the ship's operational commitments do not allow for the normal processing of a PCP/Controlled Work Package (CWP), work may begin prior to formal document approval if the local Naval Supervising Authority (NSA) commanding officer or their designated representative provides authorization." [Enclosure (52)]

70. The Makin Island Circulation Procedure, entitled "LHD-8 Procedure for Lube Oil Circulation Before Engine Start-Up" involved circulating lube oil for twenty hours through a muslin bag filter using the engine's prelube pump. [Enclosure (49)]

71. On 14 July 16, at 1720L, the ship's Port Engineer submitted the Makin Island Circulation Procedure to the Naval Surface Warfare Center (NSWC) Philadelphia Division, (b) (6), (b) (7)(C) (b) (6), (b) (7)(C) , an In Service Engineering Agent (ISEA), for review and approval. [Enclosure (50)]

72. On 15 July 16, at 0945L, the Port Engineer received approval for the Makin Island Circulation Procedure from the NSWC Philadelphia ISEA, (b) (6), (b) (7)(C) , with two caveats: 1) visually verify oil flow at all oil gallery areas; (2) take a sample of the flush oil at beginning, middle, and end of the flush duration and visually check for water/oil emulsion changes. [Enclosure (50)]

73. NSTM 233 Para 233-8.21.3 (FLUSHING) states, "This NSTM, Chapter 233, Diesel Engines, is the definitive document for lube oil flushing of diesel engines." [Enclosure (35)]

74. NSTM 233, Diesel Engines, Section 8 Para 233-8.21.4.B.2 states, "Flushing of these engines and their lube oil systems is required after fresh (jacket water) or saltwater contamination of lube oil systems. Refer to paragraph 233.8.21.17." [emphasis added] Yet, Section 8 Para 233-8.2.17 makes no mention of a hot flush or even an external flushing rig when dealing with water contamination. [Enclosure (35)]

75. Neither NSTM 233, Diesel Engines, Section 6 Para 233-6.15, nor Para 233-6.17, nor Para 233-6.18, nor Para 233-6.19.1 calls for a hot oil flush in the event an engine is contaminated with seawater. Rather, they call for circulating corrosion inhibitor throughout the engine until all entrained water is removed. A hot flush is called for in Section 6 Para 233-6.16, "prior to operating an engine which has been out of service and treated with rust preventive compounds, the engine shall be hot lube oil flushed in accordance with Section 8." [Enclosure (40), (42)]

76. NSTM 233 Para 233-8.21.11, Caution, states, "all flushing equipment, including the flushing pump, shall be rated for a minimum flow of 260 GPM when using MIL-L-2104." (Note. MIL-L-2104 is the required flushing medium. Per NSTM 233-8.21.10, MIL-L-9000 is an acceptable substitute. [Enclosure (35)]

77. NSTM 262, Lubricating Oils, Greases, Specialty Lubricants, And Lubrication Systems, states ADL-40, the flushing medium used in Freedom, is commercial SAE 40 weight oil with the same viscosity grade as 9000 series oil. [Enclosure (69)]

78. The Makin Island procedure used in USS FREEDOM employed the NR 2 MPDE prelube pump, which is rated at 44 GPM/90 psi. [Enclosure (49)]

79. The text of the Makin Island Circulation Procedure used in USS FREEDOM states that it is "not a flushing procedure." [Enclosure (49)]

80. The Makin Island Circulation Procedure used in USS FREEDOM does not accomplish the recommended engine restoration or lay-up procedures outlined in NSTM 233 for engines contaminated with seawater. [Enclosure (49)]

81. The ship's commanding officer did not inform either the operational or administrative ISIC that the Makin Island Circulation Procedure would not accomplish the recommended engine restoration or lay-up procedures outlined in NSTM 233. [Enclosure (71)]

82. On 15 July 16, blank flanges were installed in the NR2 MPDE seawater cooling system, which stopped seawater leaking into NR2 MPDE sump. [Enclosure (12), (14), (39)]

83. Half of NR 2 MPDE's crankcase covers were removed in preparation for the Makin Island Circulation Procedure. The engineer officer viewed the engine and saw that emulsified oil was present throughout the engine, to include the engine internals. [Enclosure (53)]

84. In preparation for the circulation procedure, the contents of NR 2 MPDE sump were pumped by the sub-contractor to a tank on the pier. [Enclosure (7), (17)]

85. The ship was under considerable pressure from both its operational and administrative chains of command to return to sea as quickly as possible to support exercise requirements. At a minimum, the ship was expected to get back underway no later than 18 July 16 to support an Expeditionary MCM event. [Enclosure (47), (54)]

86. On 15 July 16, the ship was visited by MajGen Owens, USMC; RADM Morneau, USN, NECC; and CAPT (b)(6) and (b)(7)(C), JMSDF. The commanding officer stated during the time between the two RIMPAC phases, that "there was no direct or overt pressure, but certainly a lot of interest in getting LCS/Ex-MCM team to sea." [Enclosure (45), (51)]

87. On 16 July 16, at 0947L, the ship commenced the Makin Island Circulation Procedure. The flush was performed by a NASSCO sub-contractor. A beginning sample was taken that showed significant seawater contamination. [Enclosure (7), (55)]

88. On 16 July 16, a Makin Island Circulation Procedure midpoint sample was taken that showed significant seawater contamination. [Enclosure (55)]

89. On 16 July 16, discussions were held between the engineer officer, main propulsion assistant (MPA), and Port Engineer regarding the potential need to extend the Makin Island Circulation Procedure. According to the MPA, the Port Engineer stated the procedure would not be extended beyond the originally prescribed 20 hour mark the following morning. [Enclosure (17), (18), (56)]

90. The Port Engineer does not recall being asked to extend the Makin Island Circulation Procedure or denying any request to extend it. [Enclosure (18)]

91. The commanding officer was onboard USS FREEDOM on 16 July 16 from 1710-1734L and 17 July 16 from 1120-1144L. [Enclosure (45)]

92. On 17 July 16, at 0547L, the Makin Island Circulation Procedure concluded. An endpoint sample was taken that showed significant seawater contamination. There was no visual evidence to indicate the procedure had improved the oil's condition. [Enclosure (7), (55)]

93. On 17 July 16, at 0950L, the engineer officer notified the commanding officer via text message that the Makin Island Circulation Procedure was complete. The text read as follows: "Sir, the flush is done. We are in progress of rigging the flush gear out and pumping the oil from the engine. Once the flush oil is removed, we will fill with new oil. I'm finishing check point paper work and standing by to close out engine sump. EDO is clearing tags on SWS and FM to MMR. I asses that we are still on track for tomorrow." [Enclosure (57)]

94. On 17 July 16, at 1030L, the engineer officer closed out the NR 2 MPDE sump. There was no SWRMC Shipbuilding Specialist (SBS) present at the close out, which was a g-checkpoint. [Enclosure (7), (17)]

95. At the conclusion of the Makin Island Circulation Procedure, contractors removed the flushing medium oil, but were reluctant to add fresh lube oil to an engine they knew was still contaminated. At the request of the engineer officer, the NASSCO Sustainment Execution

Contract (SEC) lead, (b) (6), (b) (7)(C), directed the contractors to add 270 gal of fresh oil to the NR 2 MPDE sump. [Enclosure (7), (17)]

96. On 17 July 16, the engineer officer did not, to the best of his recollection, inform the commanding officer that the Makin Island Circulation Procedure endpoint sample was unsatisfactory. [Enclosure (17)]

97. On 17 July 16, the ship's Command Duty Officer, (b) (6), (b) (7)(C), informed the commanding officer the flush was complete, but did not characterize its efficacy. [Enclosure (58), (59)]

98. On 17 July, at 1131, the commanding officer notified CTG 177.2, CAPT Cronin, that "Lube oil flush is complete. MLOCs in progress, and all preparations tracking toward an on time departure tomorrow." [Enclosure (60)]

99. On 17 July 16, at 1136L, the commanding officer notified (via email) COMLCSRON ONE, CAPT Buller: "Lube oil flush is complete; update to CTG 177.2 SEPCOR. Everything is tracking toward an on-time departure." [Enclosure (60), (61)]

100. On the morning of 18 July 16, (b) (6), (b) (7)(C) told the engineer officer that if the ship got underway with NR 2 MPDE's sump still contaminated the engine will rust. He recommended the ship remain in port to continue engine repair efforts. The engineer officer responded that there was "no appetite" to remain in port to continue repair efforts. [Enclosure (13) (17)]

101. On the morning of 18 July 16, the engineer officer brought the Makin Island Circulation Procedure beginning, midpoint, and endpoint samples to the commanding officer for his viewing. The commanding officer told the engineer officer that there was "no appetite" to remain in port and that the ship would be getting underway on time, or words to that effect. Enclosure (17), (51)]

102. On the morning of 18 July 16, following his conversation with the commanding officer, the engineer officer, along with (b) (6), (b) (7)(C), called the SWRMC DEI, (b) (6), (b) (7)(C), to discuss what steps, if any, might be taken to safeguard NR 2 MPDE given it still was contaminated. (b) (6), (b) (7)(C) recommended ensuring the prelube pump was tagged out to prevent contaminated oil from circulating throughout the engine. [Enclosure (13), (17)]

103. The commanding officer did not notify either the operational or administrative ISIC that the Makin Island Circulation Procedure had failed to fully remove the seawater contamination from NR 2 MPDE. [Enclosure (60, (61)]

104. The commanding officer did not lobby or formally request permission from either the operational or administrative ISIC to remain in port in order to continue efforts to clear contamination from NR 2 MPDE. [Enclosure (70), (71)]

105. On 18 July 16, at 0906, the commanding officer notified COMLSCRON ONE, CAPT Buller, via email, that "we are completely materially ready to get underway, and completing our final checklist preparations for our scheduled 1100 departure." [Enclosure (62)]

106. The commanding officer believed there was "no appetite" to remain in port beyond 18 July 16. He felt the LCS program could not afford another public failure to meet mission tasking. [Enclosure (51)]

107. CAPT Cronin, CTG 177.2, cannot recall whether or not he was notified that the Makin Island Circulation Procedure had been completed satisfactorily. [Enclosure (71)]

108. CAPT Cronin, CTG 177.2, did not receive a request from either the administrative ISIC or the ship to remain in port past 18 July 16 to support additional flushing to NR 2 MPDE. [Enclosure (71)]

109. CAPT Cronin, CTG 177.2, was not aware that USS FREEDOM sailed on 18 July 16 with contamination in NR 2 MPDE sump. [Enclosure (71)]

110. CAPT Buller, COMLCSRON ONE, cannot recall whether or not he was notified that the Makin Island Circulation Procedure had been completed satisfactorily. [Enclosure (70)]

111. CAPT Buller, COMLCSRON ONE, did not receive a request from either the operational ISIC or the ship to remain in port past 18 July 16 to support additional flushing to NR 2 MPDE. [Enclosure (70)]

112. CAPT Buller, COMLCSRON ONE, was not aware USS FREEDOM sailed on 18 July 16 with contamination in NR 2 MPDE sump. [Enclosure (70)]

113. USS FREEDOM got underway on 18 July 16 at 1112L to support the RIMPAC Freeplay Phase with NR 2 MPDE tagged out, to include its prelube pump, and the engine seawater cooling system blank flanges still installed. [Enclosure (7), (39), (45)]

114. A single casualty sample was taken on NR 2 MPDE during the RIMPAC Freeplay Phase 18-29 July 16), on 24 July 16. It showed significant seawater contamination. The ship did not take the actions recommended by NSTM 233. [Enclosure (63)]

115. USS FREEDOM returned to port on 29 July 16. [Enclosure (7), (45)]

116. No action was taken on NR2 MPDE from 29 July-2 August 16. The ship was scheduled to enter a Continuous Maintenance Availability (CMAV) on 2 August 16, yet according to the commanding officer, "the maintenance community, after being very responsive to various casualties (providing tech reps and parts on very short notice to keep us on-mission in RIMPAC) surprised the crew and me with the slow start upon our return. I did not expect the whole CMAV to slide left by any means, given all the contractual requirements and limitations, but I had hoped

for a faster response to emergent work. The availability was scheduled to start on 2 August 16, but even then got off to a slow start." [Enclosure (64), (65)]

117. CNSP directed Freedom to be clear of contractors for the ROKN CNO visit on 2 August 16, which resulted in the contractors being absent the entire day. [Enclosure (64), (65)]

118. On 3 August 16, the DEI arrived onboard to perform a routine, periodic diesel inspection of NR1 MPDE, but at the behest of the engineer officer proceeded to open NR 2 MPDE. The inspection revealed significant corrosion throughout the engine. [Enclosure (66)]

119. NR 2 MPDE corrosion damage is so severe the engine is beyond economical repair and must be replaced. [Enclosure (66), (67)]

Opinions

1. Three main factors contributed to the catastrophic damage to NR 2 MPDE. First, the decision to insert a DC plug into the engine attached seawater pump telltale, along with the inability to completely isolate seawater cooling to the engine, resulted in seawater contamination of the engine sump and ultimately the entire engine. Second, the ship's failure, abetted by the maintenance and technical communities, to use the proper NSTM recommended procedure for removing emulsified oil from a seawater contaminated engine resulted in contamination remaining present throughout the engine. And third, the commanding officer's decision to proceed to sea after efforts to remove contamination from the engine had clearly failed and resulted in galloping corrosion throughout the engine.

The Initial Seawater Contamination of NR 2 MPDE

2. The proximate cause of seawater intrusion into NR 2 MPDE was the ship's Casualty Response Team's decision to insert a DC plug into the engine's attached seawater pump telltale drain following the failure of the pump's mechanical seal. This action, coupled with an inability to fully isolate the engine's seawater cooling system, led to a buildup of pressure within the spacer between the pump and the engine crankcase and, eventually, seawater intrusion into the engine sump. Ship's force was unable to fully isolate seawater cooling to the engine because the (butterfly) isolation valves MSW-V-164B and MSW-V-49B leaked by. Once the engine was shut down, the attached seawater cooling pump would not have drawn suction from the sea chest through MSW-V-49B. (The valve immediately adjacent to the engine seawater cooling sea chest, MSW-V-46, was not secured because doing so would have also secured cooling to NR 1 MPDE.) The leak by, therefore, was likely predominately through MSW-V-164B, the emergency firemain back-up system, which remained under pressure with the firemain system pump running. Further isolation of the emergency firemain back-up system would have required securing MSW-V-165B (which was done) and FM-V-117 at the branch off of the main firemain header (which was not done). FM-V-117 was shut by contractors prior to the installation of blank flanges in the NR 2 MPDE seawater cooling system on 15 July. [FF (6), (7), (8), (9), (10), (42), (82)]

The failure of NR 2 MPDE's mechanical seal was signaled by a drop in firemain pressure on the afternoon of 11 July 16. In response to the drop in pressure, investigators discovered major flooding in the ship's Main Machinery Room (MMR) and water leaking at a prodigious rate from underneath the engine's free end. Unable to determine exactly where the leak was coming from, ship's force shut down the engine, attempted to isolate seawater cooling as described above, and inserted a DC plug into the leak hole. Obscured by various systems' piping and scarcely accessible, the ship's engineers did not realize the hole was the attached seawater pump telltale. Instead, they believed the water was emanating from the attached seawater pump casing drain after its plug had become dislocated. (This belief was reinforced when the first responder, (b) (6), (b) (7)(C) , announced that he had digitally explored the hole and felt threads.) Efforts were made to locate the "missing" drain plug. This initial error is somewhat understandable as the pump casing drain and telltale are located near one another (~ 12 cm apart). Still, the ship's more experienced engineers, at a minimum, once they were aware the leak was not due to a burst pipe or ejected drain plug, should have known or at least strongly suspected that the root cause of the flooding was a leaking or failed attached seawater pump mechanical seal. [FF (2), (4), (5), (6), (7), (8), (9), (10), (16), (17)]

3. The ship's engineering leadership's belief that the leak was due to a failed casing drain plug, coupled with their knowledge that the engine's seawater cooling system was not fully isolated, led them to keep the DC plug inserted in the telltale long after the leak had been stopped (it remains in place as of this investigation). Later on the evening of 11 July 16, after coming off watch as TAO, the engineer officer, after conferring with the senior enlisted engineer, (b) (6), (b) (7)(C) , and Port Engineer, (b) (6), (b) (7)(C) , reviewed a schematic of the seawater pump and visited the affected engine. His investigation led him to conclude water had been emanating from the pump telltale and not the casing drain. Armed with this information, he, along with the other senior departmental engineers, failed to recognize that, without a place to go, water leaking past the pump mechanical seal into the pump spacer would ultimately enter the engine sump. Throughout the day of 12 July 16, the NR 2 MPDE sump steadily filled with seawater and the rising level went unnoticed by the ship's engineering watchstanders. [FF (7), (8), (9), (10), (14), (15), (25)]

4. The failure of ship's force to promptly recognize that inserting a DC plug into the attached seawater pump telltale would result in seawater entering the engine sump, the failure to remove the DC plug from the telltale once this fact was known, and the failure to secure the prelube pump following engine shut-down led to emulsified oil contamination throughout the entire engine. Taken together, these failures demonstrate a departmental lack of knowledge of the engineering plant and of basic engineering fundamentals. In shipboard operating principle terms, the ship's engineering department demonstrated a lack of knowledge and an insufficiently questioning attitude. [FF (25), (29), (45)]

On 12 July 16, upon discovering oil emanating from the NR 2 MPDE sump dipstick tube and spilling onto the MMR deck, ship's force initially failed to make the connection between the earlier attached seawater pump casualty and the overflowing MPDE sump. Instead, ship's force

mistakenly ascribed the seawater contamination to a leak in the combination cooler. Later that morning, the ship's Port Engineer and the SWRMC DEI convinced the ship's engineers to consider the attached seawater pump casualty as the root cause of the engine sump contamination. The SWRMC DEI stated flatly, "if you have a DC plug in the pump telltale water will back up into the engine sump." Despite this admonition, ship's force elected to keep the DC plug inserted in the telltale as the ship prepared to pull into port. Prior to pulling in, ship's force emptied NR 2 MPDE sump three times in an effort to minimize seawater contamination to the engine. Ship's force also tagged out the engine, including the prelube pump, which had been circulating emulsified lube oil throughout the engine since the attached seawater pump casualty first occurred. (Note. The prelube pump was tagged back in when needed to support emptying the sump.) [FF (26), (27), (28), (37), (38), (39), (40), (41), (42), (43), (45), (46)]

The Failure to Adhere to NSTM Recommended Recovery Procedures for Engines Contaminated with Seawater

5. Upon learning that the engine was contaminated with seawater, ship's force, with the concurrence and support of the maintenance and technical communities, failed to conduct the NSTM recommended procedure for removing contamination from an engine flooded or immersed in seawater that cannot be started (motored). i.e., they did not lay up the engine. NSTM 233, Diesel Engines, makes recommendations for dealing with engine water, including seawater contamination that are not easy to follow. Major sections of NSTM 233, Diesel Engines, that prescribe how to deal with water contamination in an engine include:

Chapter 6:
- NSTM 233 Para 233-6.15 (LAYING UP DIESEL ENGINES WHEN MOTORING IS NOT POSSIBLE)
- NSTM 233 Para 233-6.17 (TREATMENT AFTER IMMERSION IN SEAWATER)
- NSTM 233 Para 233-6.18 (IMMEDIATE USE FOLLOWING IMMERSION)
- NSTM 233 Para 233-6.19 (ENGINES AND PARTS FOR DELAYED REPAIR)

Chapter 8:
- NSTM 233 Para 233-8.21.3 (FLUSHING)
- NSTM 233 Para 233-8.21.17 (WATER CONTAMINATION FLUSH)

[FF (40), (42), (43), (44), (47), (54)]

Confusingly, Chapter 8 Para 233-8.21.3 states a hot oil flush is required when the engine lube oil system has been contaminated with seawater and refers the reader to 233-8.21.17. Para 233-8.21.17, however, does not mention a hot flush in the procedure's steps. It is also not easily discernible whether the user should follow the prescriptions laid out in Chapter 6 or Chapter 8. Chapter 8 Para 233-8.21.17 NOTE g., states "If an engine or engine space has been *flooded* refer to NSTM Chapter 233, Diesel Engines, Chapter 6." [italics added] Chapter 6 contains procedures for engines that have been "immersed" in seawater. Users must determine for themselves whether or not their level of engine contamination rises to the level of *flooded* or *immersed*, and whether therefore they should follow the procedures laid out in Chapter 6 or Chapter 8.

Crucially, all of the recommended procedures for addressing seawater contamination, with the exception of NSTM 233 Para 233-6.15 and Para 233-6.19 (Para 233-6.19 simply refers the reader to 233-6.15), require starting the engine as part of the engine recovery/restoration process. With its attached seawater pump out of commission, USS FREEDOM *could not execute* these procedures. [FF (49), (50), (54), (55), (56)]

Upon learning NR 2 MPDE was contaminated with seawater, USS FREEDOM's engineers sought advice from both the technical community (NSWC ISEA) and shore maintenance establishment (SWRMC DEI) on how to proceed. On the morning of 13 July, in his reply to a request for assistance sent by ENCM (b)(6) and (b)(7)(C), the SWRMC DEI, (b) (6), (b) (7)(C), recommended the ship follow the procedure provided in NSTM 233 Para 233-8.21.17 (WATER CONTAMINATION FLUSH). When asked why he recommended this procedure and not one of the Chapter 6 procedures, the DEI stated he was operating under the assumption that only the engine sump had been contaminated and not the entire engine, and that the engine therefore should not be considered as having been "flooded" or "immersed" in seawater. Aware, however, that emulsified oil had been observed coming from the engine dipstick, and aware too that some 990 gal of contaminated oil had been drained from the engine sump (sump capacity 550 gal) during the first sump purge, ship's force and the SWRMC DEI should have interpreted the engine as either flooded or immersed in seawater, and should therefore have looked to NSTM 233 Chapter 6 for a recommended procedure. A severely contaminated engine sump equates to a severely contaminated engine; the NSTM does not distinguish between the two. [FF (28), (38), (40), (43), (44)]

Though not the correct procedure for the circumstances USS FREEDOM was dealing with—an engine flooded with seawater with an out of commission attached seawater pump—elements of the recommended Para 233-8.21.17 procedure, if they had been followed, would have helped stabilize the engine. They were not. Among other things, Para 233-8.21.17 states, "If it is suspected that water contamination occurred more than 24 hours prior to discovery, then a visual inspection of internal engine parts shall be conducted." Knowing the engine had in all likelihood been contaminated with seawater shortly after the original attached seawater pump casualty, i.e., on or about the evening of 11 July, ship's force and the SWRMC DEI should have performed a visual inspection of the engine. Yet no proper visual inspection of the engine was performed either by ship's force or a DEI as part of the engine repair/restoration process. The SWRMC DEI did observe the engine with one panel removed on 14 July, and the ship's engineer officer did see the engine with half of its crankcase covers removed just prior to commencing the Makin Island Circulation Procedure on 16 July, yet neither of these engine observations met the spirit or intent of the NSTM inspection requirement. [FF (47), (66)]

Ship's force performed a portion of Step 3 of the Para 233-8.21.17 procedure—empty and clean the sump—yet made no attempt at completing any other step, to include Step 2—clean valve gear and exposed internal engine components—either prior to pulling into port on 13 July or prior to starting the Makin Island Circulation Procedure on 16 July. When asked why they did not attempt to clean the engine once they knew it was contaminated, the engineer officer stated the department had too many other issues to deal with: other engineering casualties, preparations

for pulling into port, etc. While partly true—the ship had a host of engineering issues to deal with in the hours between the attached seawater pump casualty and pulling in at 1800 on 13 July, and they refueled the ship on 14 July—it does not excuse the decision to not open, visually inspect, and clean the engine during the in port period, with help from LCSRON ONE, if needed. Blank flanges were not inserted to fully isolate the engine seawater cooling system and stem the flow of seawater into NR 2 MPDE until 15 July. [FF (38), (47), (52), (60), (82)]

6. A close reading of NSTM 233, along with an understanding of USS FREEDOM's material condition, should have driven ship's force and the SWRMC DEI to conclude that the only option available to the ship was to follow NSTM 233 Para 233-6.19→Para 233.6.15 (LAYING UP DIESEL ENGINES WHEN MOTORING IS NOT POSSIBLE). Both ship's force and the SWRMC DEI knew the engine attached seawater pump was out of commission and that the engine could not be started or motored. Both were also aware that the ship would not be in port long enough to repair the attached seawater pump, and that full repairs to the engine would necessarily have to wait until after the completion of the RIMPAC Freeplay Phase, some 16-21 days hence. If, upon the ship's return to port on 13 July, ship's force and the maintenance community had moved speedily to perform the Para 233.6.15 procedure, corrosion would have been arrested and the engine stabilized until full scale repairs could be accomplished. Instead, ship's force and the maintenance community, with the approval of the NSWC Philadelphia ISEA, performed a truncated, non-standard hot oil sump circulation procedure that bore no resemblance to the NSTM recommended procedure, that failed to remove the contamination from the engine, and that may even have made things worse. [FF (40), (43), (71), (72)]

7. When USS FREEDOM returned to port on 13 July for repairs, there was heavy pressure from both the operational and administrative ISICs to get the ship back underway as soon as possible. Initial discussions explored the possibility of getting the ship underway on as early as 17 July, but 18 July, the start of the RIMPAC Freeplay Phase, was considered the absolute hard stop date by which the ship must be back at sea. Given this short timeline as a repair constraint, the SWRMC DEI proposed conducting a hot engine "flush" that had previously been performed onboard USS MAKIN ISLAND, which possesses the same engine, albeit as an SSDG rather than a MPDE. This "Makin Island Flush" (aka Makin Island Circulation Procedure) was sent to and approved by the NSWC Philadelphia MPDE ISEA, (b) (6), (b) (7)(C) . As explained above, this procedure should not have been proffered by the DEI as a suitable alternative and should not have been approved by the ISEA, as it is not in accordance with NSTM 233. NSTM 233 does not include an option for a partial flush, or recommend performing a truncated procedure if there is insufficient time to do what is required. If there is insufficient time to conduct the required procedure, the repair should be delayed until such time exists, and the engine should be laid up in the interim per NSTM 233 Para 233-6.19/Para 233.6.15. [FF (65), (67), (70), (71), (72), (85)]

The Makin Island Circulation Procedure was employed because it was readily available and had been used before (its efficacy on previous occasions is not known). But it was also employed because the maintenance team could not generate a PCP quickly enough to support accomplishing one of the NSTM 233 recommended procedures even if they'd wanted to.

Incredibly, the Makin Island Circulation Procedure text states it is "not a flushing procedure," yet all involved consistently referred to it as a "flush." It seems clear that the ISEA, SWRMC, ship's force, and the contractors executing it believed the Makin Island Circulation Procedure to at least partly meet the flushing requirements set forth in NSTM 233 Para 233-8.21.3 (FLUSHING). The Makin Island Circulation Procedure makes no mention of heating the flushing medium (oil) as is called for in NSTM 233 Chapter 8, for example, yet this was done. More problematically, the Makin Island Circulation Procedure called for using the MPDE's own prelube pump to circulate the flushing medium. The prelube pump, however, does not possesses the capacity called for in NSTM 233 Chapter 8 (44 gpm vs the required 260 gpm). As a result, the Makin Island Circulation Procedure, as written, *could not achieve the sought after result* because it circulated the flushing medium from the sump through the crankcase doors with insufficient force and did not route high pressure flushing oil through the engine's interstices. [FF (64), (65), (68), (71), (72), (76), (78)]

To repair/restore engines that have been flooded or immersed in seawater, NSTM 233 calls for draining and filling the affected engine sump and pumping rust inhibitor compound throughout the engine. The procedure's steps are to be repeated until a satisfactory sample is obtained—there is no limit on the number of times the procedure may be repeated. The Makin Island Circulation Procedure, on the other hand, prescribed 22 hours of flushing time—20 hours were actually accomplished—and did not call for using rust inhibitor compound. In addition, the Makin Island Circulation Procedure called for the use of muslin bags. Fine filter muslin bags are used to remove particulate matter, not entrained water, from engine lube oil in the course of an engine flush. While a case may be made for incorporating muslin bags into the procedure, to perhaps capture rust flakes that may have formed since the engine was contaminated or to soak up some small amount of water, the presence of muslin bags suggests the Makin Island Circulation Procedure was simply a truncated version of a traditional post-repair flush, conveniently pulled off the shelf, of the type commonly used to remove particulate matter following major work to an engine rather than a flush tailored to meet NR 2 MPDE's specific water contamination removal requirements. [FF (69), (72), (92)]

USS FREEDOM returned to port at 1804L on 13 July 16, yet seawater cooling to the engine—the source of the seawater contamination—was not secured by contractors until 15 July16. The delay allowed additional seawater to enter the engine. A more on-the-ball maintenance team, operating with a greater sense of urgency, would have made arrangements to have the seawater cooling system blanked off immediately upon the ship's return to port on 13 July 16 with LCSRON support, if necessary, and would have worked to ensure a proper inspection of the engine was performed prior to laying it up. As it happened, the Makin Island Circulation Procedure did not commence until Saturday, 16 July 16, and was performed over a twenty hour period from 16-17 July 16. **Beginning, midpoint, and endpoint samples were taken that showed no discernible (i.e., visual) change in the level of engine oil contamination.** On the afternoon of 16 July 16, the ship's engineering leadership discussed with the Port Engineer the possibility of extending the flush beyond the twenty hour mark. The Port Engineer demurred. Efforts to keep the flushing crew on hand the following morning, a Sunday, —were half-hearted and ultimately abandoned, yet it is unlikely that a continuation of the Makin

Island Circulation Procedure, given its shortcomings, would have succeeded in removing the engine seawater contamination in any case. [FF (82), (87), (88), (89), (90), (92), (94)]

The Decision to Button-Up NR 2 MPDE and Go to Sea With a Contaminated Engine

8. Despite the mistakes that led to the initial engine contamination and the failure to conduct the NSTM recommended lay-up procedure following the ship's return to port, there still existed, as late as the morning of 18 July 16, an opportunity to prevent the engine's ruination. This opportunity vanished when the engineer officer made the decision on 17 July 16 to button up NR 2 MPDE with contamination still present, and later, on the morning of 18 July 16, when the commanding officer made the decision to go to sea with a contaminated engine. These decisions set the stage for the steady accrual of corrosion throughout the engine over the next sixteen days, the full extent of which was not revealed until 3 August 16. [FF (93), (94), (118), (119)]

On the morning of 17 July 16, the engineer officer went aboard USS FREEDOM to observe the close out of NR 2 MPDE sump. Upon arrival, he was shown the unsatisfactory Makin Island Circulation Procedure endpoint sample. In his statement to the investigating officer, he admitted to not informing either the commanding officer or executive officer that morning that the endpoint sample was unsatisfactory. This fact is confirmed by a text he sent to the commanding officer, at 0950L, which stated the "flush" was complete and that underway preparations were "on track." Next, the engineer officer supervised and signed-off on the closeout of NR MPDE sump, despite being aware that significant contamination was still present. He alone was responsible for closing out the engine sump; there was no SWRMC DEI or SBS present to observe the government checkpoint. Prior to agreeing to close out the engine sump, the engineer officer directed the contractors performing the procedure to add an additional 270 gal of clean oil to the sump, which he apparently believed would dilute the sump contamination and offer some protection against corrosion once the engine was sealed. The reason given by the engineer officer for buttoning up the engine, despite the contamination, was that there was "no appetite" among senior leaders such as the commanding officer and operational and administrative ISICs, to remain in port beyond 18 July 16, which made moot in his mind the possibility of performing additional engine work. The engineer office also stated that at the time he buttoned up the sump he was unaware of just how contaminated the oil was, that there was only a thin film of water on the sample bottle bottom, and that it was only on Monday morning, after the sample had had a chance to emulsify, that he realized the severity of the contamination. [FF (17), (85), (92), (93), (94), (95), (96)]

The commanding officer, for his part, told the investigating officer that he was not informed on 17 July 16 that the Makin Island Circulation Procedure endpoint sample was unsatisfactory, despite having been onboard the ship that day from 1120-1144L. As stated above, he was notified via text by the engineer officer that the flush was complete and that everything was on track for getting underway the following day. The engineer officer's report that the procedure was complete, which did not characterize the procedure's results, was interpreted by the commanding officer to mean the flush had been completed satisfactorily. The commanding

officer did not speak in person with the engineer officer regarding the procedure and did not view the engine while onboard. At 1131L, the commanding officer also reported to his operational ISIC, CTG 177.2, CAPT Cronin, without explication, that the "flush" was complete. CAPT Cronin was not informed that the procedure endpoint sample was unsatisfactory. At 1136L, the commanding officer notified COMLCSRON ONE, CAPT Buller, that the "flush" was complete, but did not characterize it further. The lack of characterization was interpreted by CAPT Buller to mean the procedure had been completed satisfactorily. [FF (91), (93), (97), (98), (99), (105), (107), (109), (110), (112)]

On the morning of 18 July 16, the day the ship was scheduled to get underway, the ship's senior enlisted engineer, (b)(6), (b)(7)(C), made clear to the engineer officer that if the ship went to sea with the engine full of contamination it would likely be ruined. In response, the engineer officer brought the beginning, midpoint, and endpoint flush samples to the commanding officer for his viewing. The commanding officer acknowledged the samples were unsatisfactory, but also made clear once more that there was "no appetite" to not get underway as scheduled later that morning. The commanding officer and engineer officer did not discuss what steps, if any, should be taken to further safeguard NR 2 MPDE. The commanding officer did not notify either his operational or administrative ISIC that the flush endpoint sample was unsatisfactory or that the engine had been buttoned up with contamination still present. Nor did he request from either CAPT Cronin or CAPT Buller permission to remain in port to effect additional repairs to NR 2 MPDE. USS FREEDOM went underway later that morning with NR 2 MPDE tagged out but filled with contamination. Although the prelube pump was secured and blank flanges still inserted in the seawater cooling system piping, the crankcase atmosphere supported the proliferation of corrosion throughout the engine over time. [FF (81), (98), (99), (100), (101), (103), (104), (105), (106), (107), (108), (109), (110), (111), (112)]

On 24 July 16, while underway for RIMPAC Freeplay Phase, the ship sampled NR 2 MPDE sump and confirmed the sump oil was still contaminated. This should have been considered a brand new casualty. NSTM 233 should again have been referenced and prompt actions taken to address the problem. NSTM 233 makes clear that taking prompt action is essential when an engine is contaminated with seawater if damage is to be minimized and the engine saved. The sump should have been drained, the engine opened and cleaned, and discussions held with the operational ISIC regarding whether or not the ship should return to port for repairs. None of this occurred. Here again, the desire to meet mission tasking overrode engine repair considerations. No discussion occurred amongst the command triad and senior engineering leadership regarding the parlous state of NR 2 MPDE at any point during the RIMPAC Freeplay Phase. Tagged out, blanked off, and unavailable for use, NR 2 MPDE was left to decay. [FF (50), (114)]

9. To understand how NR 2 MPDE came to be damaged two key questions must be answered: 1) why, on 17 July 16, did the engineer officer not inform the commanding officer that the Makin Island Circulation Procedure endpoint sample was unsatisfactory; and 2) why, on 18 July 16, did the commanding officer not inform either his operational or administrative ISIC that the procedure had failed to remove the seawater contamination? The answer to both questions is

straightforward: neither the engineer officer on the 17th nor the commanding officer on the 18th wished to notify their immediate superior that they might not be able to get underway on the 18th to support the RIMPAC mission. In both their minds, the message from senior leaders, to include CTF 177, CTG 177.2, and COMLCSRON ONE, was clear: it was crucially important, not only to the success of RIMPAC, but to the success of the Ex-MCM concept and the broader LCS program that USS FREEDOM get underway on 18 July 16 to support the RIMPAC Freeplay Phase. There was in their view, as was frequently mentioned during the investigation, "no appetite" on the part of senior leadership for the ship not to get underway on time. [FF (63), (85), (86), (93), (98), (99), (105), (106), (107), (108), (109), (110), (111), (112)]

Although the amount of pressure applied to CDR Wohnhaas by his superiors cannot be quantified precisely, there is no question but that it was severe and that he felt it keenly. The ship received numerous visits from senior leaders, including flag and general officers, both before the ship sailed for RIMPAC on 9 July 16 and during the 14-17 July 16 repair interregnum. The list of senior leaders who visited the ship included MajGen Owens, USMC; RADM Morneau, NECC; RDML Kilby, CTF 177; CAPT Buller, COMLCSRON ONE; and CAPT (b)(6) and (b)(7)(C) JMSDF. In advance of RIMPAC, CAPT Buller visited the ship to impress upon the crew the importance of USS FREEDOM RIMPAC mission to the LCS program. He alluded to the Ex-MCM concept as being in line with ADM Swift's desire to use the Pacific as the "Navy's testing grounds." Given the recent high visibility incidents involving USS FORT WORTH (LCS 3) and USS MILWAUKEE (LCS 5), leadership at every level within the LCS program felt pressure to deliver a "win" for the program, or at a minimum avoid another mission failure. The RIMPAC Ex-MCM demonstration was an opportunity, they believed, to exhibit the ship's combat capability in a new and different way, and to perhaps modulate some of the program's critics. Made aware of the unsatisfactory samples just prior to getting underway on 18 July 16, and after having informed his superiors that repairs were on track throughout the repair period, letting the chain of command know that efforts to stabilize NR 2 MPDE had failed, that the ship would not be able to get underway on time, and that still more time would be required to repair the engine would have been an unpleasant, difficult message to deliver. [FF (63), (85), (86)]

Still, we rely on our commanding officers to make difficult decisions and to keep the chain of command informed no matter the circumstances. It did not help that the engineer officer did not inform him of the unsatisfactory endpoint sample on the 17th; it would have been a little easier to deliver the hard news the day prior to getting underway than the day of. And while there surely was significant pressure to get underway on time, the commanding officer acknowledged that this pressure was not explicit or overt; it was merely strongly implied. CDR Wohnhaas's decision to withhold critical information from his superiors denied them the chance to assess and decide for themselves whether or not it was worth risking permanent damage to NR 2 MPDE to get the ship underway on time. It is left to senior leadership to assess the degree to which the egregiousness of the commanding officer's decision to not inform his superiors of the still extant casualty is mitigated by the pressurized atmosphere that existed when the decision was made. [FF (63), (85), (86), (93), (98), (99), (105), (106), (107), (108), (109), (110), (111), (112)]

Conclusion

10. The catastrophic damage to NR 2 MPDE resulted from a series of errors culminating in the decision to return to sea on 18 July 16 with the engine still contaminated. The first major error—the decision to insert a DC plug into the attached seawater pump telltale—stemmed from the ship's engineers' lack of familiarity with the engineering plant and their desire to prevent, as quickly as possible, seawater from leaking into the Main Machinery Room. Upon realizing they had plugged the pump telltale and aware that their attempts to isolate engine seawater cooling had been unsuccessful, they failed to grasp that these two facts in combination would lead to seawater contamination of the engine. Because they did not recognize that seawater was steadily entering the engine sump, they made no effort to secure the engine's prelube pump, which continued to circulate emulsified oil throughout the engine, or take more dramatic measures to isolate seawater cooling. Upon discovering the engine sump was full of emulsified oil, they initially failed to recognize the attached seawater pump casualty was the source of the contamination. Between the time they discovered the contaminated engine sump (PM 12 July 16) and initiated the Makin Island Circulation Procedure (AM 16 July 16) they made no effort beyond emptying the sump to perform NSTM recommended restoration procedures, to include formally inspecting the engine with a certified DEI and cleaning the engine internals and sump with lint free rags.[FF (2)-(29), (116), (118)]

11. The second major error was the failure by all concerned—ship, Regional Maintenance Center (RMC), and ISEA—to adhere to the NSTM 233 recommended procedure, stipulated in Chapter 6, for a contaminated engine that cannot be started (motored) and whose repair must therefore be delayed. Upon being notified of the casualty, the SWRMC DEI wrongly recommended the ship follow NSTM 233-8.21.17, which applies only to engines that are not flooded and that can be started. Both he and the ship should have considered the emulsified lube oil discharging from the engine dipstick as prima facie evidence that the engine was flooded or immersed in seawater, and should have consulted NSTM 233 Chapter 6, rather than Chapter 8, for guidance. Chapter 6, in turn, would have led them to pursue laying up the engine prior to the ship returning to sea for the RIMPAC Freeplay Phase. Operating under the apparent belief that introducing and circulating some amount of clean oil through the engine sump would be better than doing nothing at all, the SWRMC DEI proposed, and the NSWC Philadelphia ISEA approved, a non-standard, non-flush circulation procedure, limited to only 20 hours, that used the engine's own, low-rated prelube pump, rather than the stout external pump prescribed by the NSTM, to circulate clean oil from the sump through each crankcase door. Predictably, the procedure failed. Given its intrinsic shortcomings, extending the circulation procedure beyond twenty hours, had it been attempted, would almost certainly not have improved the result.[FF (32), (33), (44), (47)-(56), (65)-(67), (70)-(80)]

12. The final major error was the compound error made by the engineer officer and commanding officer to button up the engine with contamination still present and not notify the chain of command. It was evident after the midpoint sample was taken on the evening of 16 July 16 that the oil circulation procedure meant to clear contamination from the engine was not working, yet this information was not relayed to key decision makers and only half-hearted efforts to modify or extend the procedure were explored. Despite the concerns raised by several members of the

maintenance team, and despite a widespread understanding of the potentially catastrophic implications of not removing the seawater contamination from the engine, the maintenance team failed to notify their superiors or change course. Had the engineer officer or main propulsion assistant notified the commanding officer on either 16 or 17 July 16 that the circulation procedure was not working the captain would have had time to discuss potential alternate repair options with his chain of command, and the operational ISIC would have had time to adjust the Freeplay schedule of events to support USS FREEDOM's absence. Instead, as we've seen, the commanding officer was not notified that the circulation procedure failed until a few hours before his scheduled underway, whereupon he chose not to let his superiors know. [FF (63), (85), (86), (93), (98), (99), (105)-112)]

13. No work was accomplished on NR 2 MPDE from the time the ship returned to port on 29 July to 3 August 16 when the extensive corrosion was discovered. While the ship was underway for the RIMPAC Freeplay Phase, both the ship's engineers and the RMC DEI shop discussed internally their strong suspicion that NR 2 MPDE was corroding. Yet the maintenance team was slow to get aboard the ship and assess the engine's condition once the ship had returned to port. Although promptly opening and inspecting the engine at this point would not have made any significant difference to the extent of the engine corrosion, the delay in opening, inspecting, and initiating repairs to the engine is emblematic of the maintenance team's nonchalance and lack of urgency regarding NR 2 MPDE. Tellingly, the corrosion damage to NR 2 MPDE was discovered as part of a routine, regularly scheduled diesel inspection of NR 1 MPDE, and not because the engine was being examined at the ship's, squadron's, or RMC's insistence. [FF (116), (118), (119)]

14. Engineering casualties aboard LCS ships invariably lead to discussions of whether or not the ship class's operational concept—specifically the crewing and maintenance concepts—contributed to or exacerbated the casualty. In other words, did USS FREEDOM's small crew, hybrid-trained Sailors, dependence on off-ship support for preventive and corrective maintenance, or reliance on OEMs and contractors to maintain shipboard systems play a role in the loss of NR 2 MPDE? In this instance, the ship's gauges and instruments worked properly and the response to the failed mechanical seal casualty by the ship's Casualty Response Team was timely, if ultimately self-defeating. The crew's unfamiliarity with the seawater pump telltale's location, and their subsequent decision to plug it, cannot be laid at the feet of the hybrid Sailor concept, or blamed on the minimum manning concept generally; it is rather a training, and partly a design, issue, though their lack of experience with operating the engineering plant may be considered a minor contributing factor.

USS FREEDOM's engineering department of 15 Sailors is challenged to provide the elementary monitoring and oversight the plant requires and is quickly overwhelmed when forced to deal with multiple simultaneous casualties. The casualty to NR 2 MPDE was one of many significant casualties the engineering department had to deal with prior to and during RIMPAC. The department's failure to open, inspect, disassemble, and wipe down the engine once it had been contaminated was due in part to their having to deal with numerous engineering casualties during the period in question, while at the same time supporting entering port and refueling

requirements. The inability to tear down the diesel is due to USS FREEDOM's longstanding engineering plant reliability issues as much as it is an indictment of the class's crewing and maintenance concepts. If the LCS crewing and maintenance concepts as currently conceived are to succeed, LCS plant reliability must improve. In sum, none of the LCS class maintenance concept's intrinsic properties, beyond the limited capacity inherent in a small engineering department, appears to have contributed in a significant way to this casualty. This should not, however, be taken as proof of the operational concept's validity, but merely as a data point in the concept's still ongoing evaluation. [FF (17), (25)]

Recommendations

1. COMLCSRON ONE provide continued oversight of USS FREEDOM's engineering department until satisfied a shipboard culture that embraces the core watchstanding principles of Integrity, Formality, Procedural Compliance, Level of Knowledge, Questioning Attitude, Forceful Backup, and Organizational Risk Management has been established.

2. COMLCSRON ONE require all ships to obtain and make freely available the CNSP Watchstander Guide.

3. NAVSEA/TYCOM work to enter all LCS ships into the Diesel Readiness System program immediately.

4. NAVSEA develop an EOCC procedure for water/seawater intrusion into a MPDE.

5. NAVSEA develop a NSTM procedure for ships to follow in the event of water/seawater intrusion into a MPDE at sea that they can use as an interim solution to stabilize the engine until they pull into port.

6. NAVSEA update MRC PMS 2331/025 MRC R-43W (H8MQ) - Perform Analysis for Water in Oil Obtained from MPDE Sump Using Kittiwake Oil Test Center (OTC) to include a requirement (R-check) to perform the check in the event of a water/seawater intrusion casualty to the engine.

7. NAVSEA/CNSP N48 develop and issue a class advisory alerting LCS ships of recent issues with engineers inserting plugs into attached seawater pump telltales that provides explicit guidance on how to address a leaking or failed attached seawater pump mechanical seal.

8. PEO LCS examine whether the LCS (1 Variant) MPDE attached seawater pump mechanical seals' mean time between failure rate is excessively high. If so, consider a redesign or wholesale pump replacement.

9. PEO LCS/NAVSEA review the design of the attached seawater pump to determine the feasibility of adding a pipe extension, as called for in OEM technical manual, from the telltale to a location out from underneath the engine.

10. LCSRON ONE direct all LCS (1 Variant) ships to conduct formal training on the MPDE attached seawater pump telltale: its purpose, its location, how to distinguish it from the adjacent casing drain plug, and what to do in the event it leaks.

11. SWOS/SOSMRC review the LCS engineering training curricula for officer and enlisted personnel to ensure mechanical seal fundamentals are taught and the purpose of a telltale made clear. Consider adding this incident as a case study or topic of classroom discussion.

12. PEO LCS/CNSP N48 examine the possibility of adding MPDE attached seawater pumps to the LCS Condition-Based Maintenance (Plus) program.

13. NAVSEA develop a readily available, off-the-shelf Process Control Procedure (PCP) for use in the event of a MPDE seawater intrusion casualty. Ensure all RMCs have the NSTM 233 recommended rust inhibitor compound and flushing rig on hand at all times to enable engine repair/restoration procedures to be accomplished promptly.

14. NAVSEA direct RMC DEIs to review and discuss this incident emphasizing the importance of strict adherence to NSTM 233 procedures for engines contaminated with seawater.

15. NAVSEA rewrite NSTM 233 to more clearly delineate the actions to be taken in the event of a water intrusion casualty. At a minimum, clearly distinguish between non-seawater and seawater intrusion procedures, more clearly define the terms "flooded" and "immersion" and "internal" and "external" flush; add greater specificity to Chapter 6 233-6.17 and 233-6.18, as well as Chapter 8 Para 233-8.21.17, and address the disconnect between Chapter 8 Para 233-8.21.3, which recommends an engine hot flush, and Para 233-8.21.17, which makes no mention of a hot flush.

16. Recommended disciplinary action:

(b)(5)

(b)(5)

(b)(6) and (b)(7)(C)

W. A. HESSER